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CONCLUSIONS.

1. The disease prevailing in the hospital was a fever caused by infection with *Bacillus paratyphosus* B.
 2. The incubation period was 5 to 10 days, averaging 8 days.
 3. The organism was recoverable by blood culture from cases on the first day of the disease.
 4. The infection was spread by finger conveyance from case to case in the wards.
 5. Strict medical asepsis was sufficient to control the spread of the disease.
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OUTBREAK AND SUPPRESSION OF PLAGUE IN PORTO RICO.

AN ACCOUNT OF THE [COURSE] OF THE EPIDEMIC AND THE MEASURES EMPLOYED
FOR ITS SUPPRESSION BY THE UNITED STATES PUBLIC HEALTH SERVICE.

By RICHARD H. CREEL, Passed Assistant Surgeon, United States Public Health Service

Summary.

There were 55 cases of human plague in the Porto Rico epidemic, 10 having occurred at the date of announcement of the disease and 45 thereafter. All were of the bubonic type, with a mortality of 65 per cent.

Flea infestation in Porto Rico is very low compared with other tropical countries. The data is not sufficient to determine if there is a seasonal variation. The species of fleas encountered on rodents were: *Xenopsylla cheopis*, *Echidnaphaga gallinacae*, *Otenocephalus canis*, and *Pulex irritans*, with the addition of *Rhynchoprion penetrans* on human host. The infestation of rats by chicken flea in San Juan is noteworthy. The decline in rat population, as indicated by the weekly catch, was marked and to a large degree was the result of rat proofing. The rat infection extended to four points outside of San Juan: To Carolina, a distance of 14 miles; Caguas, 23 miles; Arecibo, about 50 miles, and Rio Piedras, 3 miles. Only in the first-named village did human cases occur.

The presumptive evidence points to an extension by infected rats in merchandise. The infection in Rio Piedras might have been carried there by migratory rodents.

In Porto Rico the *Mus norvegicus*, *Mus alexandrinus* and *Mus rattus* infest houses, but the former predominates. *Mus alexandrinus* is the species found in rural districts. Sufficient data is not at hand as to the variation of breeding, but it is probable that there is no seasonal fluctuation of this nature among the rodents of Porto Rico.

General Considerations.

INCEPTION OF RAT EPIZOOTIC.

Plague was determined present in San Juan on June 19, 1912, at which time 13 human cases or more had actually occurred. That there had been for several weeks previous a rodent infection seems highly probable, not only from the well-known precedence of human infection by rat epizootic, but by the results of inquiries in San Juan as to the evidence of a previous rat epizootic. From reliable sources of information it developed that a marked and unexplainable mortality among rats along the water-front district was noticed as early as the latter part of April or the first part of May. An inspector in the customs warehouse reported that at the above-mentioned period he had noticed several dead rats each morning upon opening up the warehouse. He was especially impressed because the mortality could not be accounted for, no poison having been distributed. A similar recital was elicited from other warehouse men. This observation of rodent epizootic, it is to be noted, was made in warehouses receiving foreign shipments.

DURATION OF INFECTION IN SAN JUAN.

From the time service eradivative measures were inaugurated until the last plague rat was captured in San Juan, there elapsed a period of 67 days, or 84 days from the official declaration of plague. The decline and cessation of infection can be ascribed only to the marked reduction of rats with their plague-carrying parasites. This result, while immediately due to trapping and poisoning, was very largely dependent upon the thorough rat-proofing measures instituted. Rat proofing not only deprives the rodent of an abode—a place to live and breed—but it removes from him his food supply. In urgent need of new quarters and food, the dispossessed rodent, provided he has escaped death from the hands of workmen, falls a prey to poison or traps. It is thought that the most potent factor in the decline of fleas was the destruction of these parasites in the measures incident to rat proofing. When a food depot was rat proofed, rat runs were securely sealed in by the concrete, and the fleas therein were thus destroyed. The widespread use of petroleum likewise caused a diminution in their numbers.

GENERAL DESTRUCTION OF PROPERTY AS ANTIPLAGUE MEASURE NOT RATIONAL.

In the first days of the epidemic there was a widespread belief that Puerta de Tierra should be burned. The result of this procedure would not have been more effective in preventing plague than was rat proofing. The rats would have been scattered to all parts of the city, and possibly a migration started that would have created a

widespread dissemination of infection throughout the island. There would have been left homeless several thousand people, and aside from the question of property rights and legal involvements there would have been destroyed several million dollars of property that otherwise has been saved. The contention that many unsightly houses would have been destroyed by a general conflagration and replaced thereafter by better appearing construction should not enter into general sanitary considerations. Some stress is laid on this subject as an argument against general destructive measures which have no place in practical sanitation.

GENERAL INSANITARY CONDITIONS NOT PRODUCTIVE OF PLAGUE.

In Porto Rico, as was noted in India, general insanitary conditions did not seem to be a factor influencing in any way the incidence of human cases. The most squalid part of Puerta de Tierra, a section located on the seashore, where from the nature of the swampy ground the houses had been built more or less elevated, was especially free from human cases. From a superficial viewpoint one would have expected this section of congested shanties and indescribable squalor to have suffered heavily from the ravages of the disease. The swampy nature of the ground, which is more or less inundated by the daily tides (which necessitated an elevated construction), operated for the salvation of these people. The better part of Puerta de Tierra was the section that had the majority of cases. The whole of Puerta de Tierra, however, despite its present unsightly and general insanitary condition, is to-day the district of San Juan most free of rats, and, consequently the best part of the municipality, from a plague standpoint. Of the 1,127 buildings, all are either elevated 2 feet with underpinning free or have a concrete floor and side walls. The marked diminution in rat population could have been secured in no other way than by rat proofing, as it is impossible to prevent the people residing there from throwing more or less foodstuffs about the streets and lots.

UNUSUAL INCREASE IN MICE POPULATION.

Accompanying the tables of rats caught is given the catch of mice (*Mus musculus*). No bounty was paid for mice, and the traps used were a large pattern intended solely for the catching of rats. While any efforts of the trappers along this line were discouraged, they were directed to turn in all captured mice. The increasing number of mice, therefore, which would have been considerably multiplied had no special effort been made to catch them, all the more emphasizes the decrease in the rat population. It is well known that mice do not live or multiply in numbers when associated with rats (*Mus rattus* or *Norvegicus*).

Description of the Municipality of San Juan.

The city of San Juan, the capital of Porto Rico, with a population of 50,000, is located on a headland. The site of the city is really in the form of a peninsula separating San Juan Bay from the ocean. Two narrow estuaries cut through this tongue of land with the formation of two islands. The two estuaries, however, are well bridged. On the point of the peninsula is located the old city, together with the water front district called La Marina and a small suburb called La Perla.

Continuing inland, Puerta de Tierra is next met with. This is a district of San Juan, built almost wholly of frame construction, and separated from the old city by a quarter of a mile of unbuilt-upon land. Continuing farther toward the base of the peninsula, Santurce is encountered. It is of modern construction and for the most part the buildings are frame. It is separated on the one side from Puerta de Tierra by a well-bridged estuary with a considerable stretch of unoccupied land, and on the other side from the mainland by an estuary which is likewise well provided with bridges. While this territory comprises the municipality of San Juan, the different types of buildings in the various districts, the varying social conditions that obtain in each, and the fact that some of these localities are well separated one from another, make it necessary to allude to each district separately.

Inception of the epidemic.

The first suspicious case examined was that of a patient, on June 15, in the district of San Juan, known as Puerta de Tierra. The necropsy revealed a "double pneumonia in stage of red hepatization with left axillary bubo." Smears from the tissues and exudate of the cadaver were made and studied jointly by Dr. Gonzáles Martínez, bacteriologist of the insular department of sanitation, and Dr. F. J. Hernández, assistant bacteriologist, with Surg. S. B. Grubbs, of the United States Public Health Service, in conference. A bacillus was observed showing bipolar tinctorial peculiarity when stained. Some stress was laid on the fact that it was gram negative, nonmotile when observed in hanging drops of fluid exudate, and that it appeared bipolar when stained.

Between June 15 and June 19 other similar cases occurred and the bacteriological studies continued. A guinea pig was injected intraperitoneally with the exudate from the peritoneal cavity of a suspected case. The animal died of a mixed infection, but smears made from tissues and exudates showed large numbers of bipolar bacilli. The organism was not isolated in pure culture nor Koch's postulates for its identification carried out; but the fact that it was

constantly observed in the suspicious cases examined, together with the marked clinical symptoms and increasing number of cases, justified the diagnosis of plague.

On June 19 plague was officially declared present in San Juan, and the acting governor requested by cable the services of an officer of the United States Public Health Service experienced in plague work. The insular authorities, especially the acting governor, Mr. M. Drew Carrel, and the acting director of sanitation, Dr. W. R. Watson, as soon as the diagnosis of plague was determined, acted with a decision and honesty of purpose seldom seen in the inception of plague epidemics, and with rare frankness a proclamation was promptly issued making public the presence of the infection not only to the people of San Juan but to all the world.

In accordance with the request of the acting governor that a service officer experienced in plague be sent to Porto Rico, I received orders on June 20 to sail from New York, and arrived in San Juan June 27. Asst. Surg. C. L. Williams sailed on the same boat. From that date to the time when the service assumed charge of plague suppressive measures, I was associated in an advisory capacity with the director of sanitation.

On June 30 it was agreed, at a conference with the acting governor, Mr. M. Drew Carrel; the director of sanitation, Dr. W. F. Lippitt; and Surg. S. B. Grubbs, that all work pertaining to the eradication of plague would be turned over to the United States Public Health Service. At this conference it was proposed that the work of the Public Health Service should embrace the purely eradivative activities, and that the insular department of sanitation should attend to the hospitalization of cases; the maintenance of isolation and detention camps; the furnishing of office and laboratory buildings necessary for the service operations, and all unexpendable supplies; the collection and disposal of garbage, and the inspection of suspicious dead. The necropsy of suspicious cases was to be done jointly by the local department and the service, the bacteriological procedure being carried out in the service laboratory.

In addition to suppressive measures, the maintenance of detention camps and the hospitalization of cases were later turned over to the service.

Organization of Work.

The service plan of operation decided upon embraced the following: (1) The quickest possible rat proofing of the whole city; (2) the thorough supervision of inland-bound freight, that no rodents should escape from San Juan in packages of merchandise; (3) a special force of men for widespread trapping and poisoning; (4) a laboratory force to examine all captured rodents; (5) the tagging of all rats collected so

that the location of any infected rodent would be known and the progress of infection mapped out; and (6) the sulphur fumigation (in conjunction with intensive rat proofing) of all infected premises. Disinfection was not utilized, being considered not pertinent to antiplague measures in absence of the pneumonic type, aside from involving a waste of time and money. In its stead, however, flea-destruction measures were observed. Sulphur fumigation and petroleum spray were the agents employed for this purpose.

This plan followed along the lines of the service organization employed in San Francisco during 1908, which was attended by such satisfactory results. Such modifications were made as local conditions required. It was recognized that merely to confine measures to individual foci of infection would not arrest the march of infection and would be inoperative to any early termination of cases, either rodent or human; and that while both human and rodent foci merited immediate treatment, more especially the latter, eradicated measures should be equally vigorous in the sections of the city that were as yet free from infection.

The week following June 30, the date of the conference at which the service was requested to take charge of plague work, was devoted to securing a force of competent employees and providing an effective rat-proofing ordinance. Due to the interested cooperation of the director of sanitation, the organization was greatly facilitated by the acquisition of a number of men who had proven their worth in the local department and were given indefinite leave to work with the service.

Some time previously a tentative rat-proofing law had been drafted by the insular board of health. To this was added at suggestion of your representative a section for rat proofing of buildings already constructed; dwellings to be elevated 2 feet, with underpinning free, or to be surrounded at their perimeter by concrete wall extending 2 feet below the surface of the ground and fitting flush to the floor of the house; the requirements for the rat proofing of any place that kept provisions, such as groceries, bakeries, markets, etc., by concrete floor and walls, the latter extending 2 feet below the ground level and 1 foot above the floor level; a rat-proofing section for stables and a section for rat proofing chicken pens. Likewise the section for rat proofing of future constructions was changed, giving specific requirements for elevation with free underpinning or requiring concrete floor and walls. The operation of this law will be referred to in another paragraph.

Proper blank form was provided by the attorney general with the paragraph containing penalty for violation thereof printed on the reverse side. Three thousand traps of a picked pattern were cabled for—1,500 cage and 1,500 snap traps. This number was augmented

by a similar number in the latter part of July, and again in August so that 9,000 traps were used throughout the island. A suitable building was secured as an office, and blank forms for inspection reports, laboratory reports, rat reports, etc., were devised.

In response to a cable request Asst. Surg. J. R. Ridlon and Pharmacist F. L. Brown were ordered to San Juan for duty in connection with plague-suppression measures.

A special laboratory for the examination of rodents had been put in operation on June 30 by Maj. F. F. Russell, of the United States Army. The building was well isolated and admirably located for this work and had been selected in the latter part of June by Surg. S. B. Grubbs and Dr. W. F. Lippitt. Upon his arrival, Asst. Surg. Ridlon was placed in charge of this laboratory, assisted by Acting Asst. Surg. F. J. Hernández. On August 26 Asst. Surg. Ridlon was ordered to take charge of the service operation in Mayaguez. He was succeeded in the laboratory by Passed Asst. Surg. C. W. Chapin, who had been ordered to San Juan by the bureau for that purpose. Arrangements were made with the department of sanitation for the preparation in the department laboratory of arsenic and phosphorus poison.

Thus in the second week of July an organization fully equipped for the eradication of plague was set to work.

Due to the excellent preliminary work performed by the local sanitary department it was possible to institute at once the eradicated measures of rat proofing, widespread trapping and poisoning, and inspection of outgoing freight.

Disinfection was not employed, being considered a waste of time and money. All outbound freight was either unpacked and examined or treated by sulphur fumigation in an especially constructed sulphur chamber. The disinfection of personnel was ignored as not being pertinent to antiplague measures.

The destruction of buildings was considered as unjustifiable in a general way, unless done by the owner in preference to rat proofing. There were a few exceptions to this policy, notably one infected house in Carolina, the thick adobe walls of which were riddled with rat runs. The immediate destruction of rat harborage on any premises on which a plague-infected rodent was taken was considered of paramount importance, considerably more so, in fact, than the treatment of buildings in which human cases occurred, though both contingencies were considered as meriting prompt action.

On removing flooring the space beneath was drenched with petroleum. The Haffkinization of the population was not undertaken by the service, inasmuch as the value of this procedure has not been sufficiently demonstrated to justify the expenditure of labor and money when more effective measures are available. The work done by the service can best be described under the headings of "Rat-

proofing," "Rat trapping and poisoning," "Freight inspection," "Laboratory examination of rats," and "House inspection for enforcement of garbage disposal and the maintenance of premises free of rat harbors."

Rat Proofing.

Under Appendix I can be observed the provisions of the rat-proofing law. The city of San Juan, with its barrios of Santurce, Puerta de Tierra, and those parts of the town known as La Marina and La Perla were divided into eight districts, and an inspector was assigned to each one. Owing to the inexperience of these men, special instruction and field demonstration were necessary in the earlier days of the work. In this way your representative personally inspected and indicated structural changes, when necessary, for rat proofing of all buildings in Puerta de Tierra, the Marina, La Perla, and a great many in the old city and in Santurce. Similar instructions were given to the assistant sanitary engineer of the insular department who, later on, attended to the rat-proofing procedure for the inland towns. Inasmuch as repairs incident to rat proofing would involve sums of money from a few dollars in some buildings to two or three thousand in others, it was deemed advisable to have each inspector thoroughly grounded in the knowledge of his duties. Before being intrusted with any discretionary power each inspector was personally instructed in all the minutiae of rat proofing.

OLD CITY.

In addition to the eight inspectors, two men were employed as special inspectors to supervise the rat proofing of the old city where predominated the type of construction locally known as "mamposteria" and similar in type to the well-known adobe material. Both were long experienced in structural work, and one was a graduate engineer. After receiving instructions as to their specific duties, both of these men, Mr. Eugene Chase and Mr. Martin Paniagua, did most excellent work, as indeed did all the other inspectors except two or three who were discharged for incompetency. Aside from containing a type of building that, because of its soft adobe walls, furnished harborage for rats on a large scale, the old city contained the docks, warehouses, and the majority of the large groceries and markets. San Juan, being the main port and the big distributing point for the island, contains warehouses and large storehouses of provisions greatly in excess of its urban population. It has two or three times the number of these places usually seen in cities having the population of San Juan, which is estimated to be 50,000.

The question of rat proofing the mamposteria construction was a serious problem. Though this construction is somewhat different

from the "pukka" houses in India, the description of buildings in Bombay by the Indian Plague Commission, both as to the nature of the material and the degree of rat infestation, makes the similarity of construction in Bombay and San Juan very striking. In one building of this material two cases of plague acquired their infection, and, on destroying the walls, which were 2 or 3 feet thick, nine rats were taken from their interior. The necessity, therefore, for rat proofing this kind of building was imperative.

The term "mamposteria" is rather comprehensive, embracing several different kinds of construction. "Mamposteria antigua" (old mamposteria), also known as "mamposteria concentrada," is composed of a mixture of clay, crushed brick, and lime. The walls of this material are generally 2 or 3 feet thick and do not extend below the ground. Its durability depends upon the exclusion of moisture, and for this purpose there is applied an outer capping of plaster. From year to year, as this outer coating wears off, it is replaced by a new veneer. If moisture gains access to the interior of the walls, the mixture loses its adhesive qualities and disintegrates.

The material of the old mamposteria as built by the Government formed a composition that was of enduring hardness, but the commercial edifices were differently made, so that many of the latter, despite the thickness of the walls, or rather by reason of the same, furnished excellent rat harborage, being quite pervious to the passage of rats. With a penknife a hole could easily be made through the walls of some of the San Juan buildings. Brick buildings are likewise called mamposteria. Some few of them, of more recent construction, are of kiln-burnt brick, well laid in cement mortar. These were found to be rat proof, except in those structures that possessed no foundation walls. Other brick buildings, however, are of soft sun-dried brick, laid in a mixture of clay, sand, and lime, or clay only. This construction was likewise often observed to be perforated by rat runs. It was thus impossible to make the old city completely rat proof save by demolition of these buildings—an economic impossibility.

An expedient, however, was adopted that made the majority of mamposteria structures comparatively rat proof. This embraced the requirement of a concrete floor, in all places that contained provisions, with a 4-inch capping on the soft walls extending 2 feet into the ground and upward above the floor level. For warehouses and wholesale groceries, this capping extended upward 4 feet. For smaller groceries, restaurants, and similar places where the walls were always exposed to view, the facing was required to be of only 1 foot in height. In this way, should a rat escape from a hole above the capping and descend to the floor it could not regain its former abode. Likewise, any rat hole well up from the floor level could be easily seen and closed, whereas lower down it might escape notice. The

heavy facing also protected the walls at the lower points where heavy articles of merchandise would most frequently break a veneer of cement or lime mortar and give entrance to a rodent.

This capping provoked some opposition. Many of the people could not understand that mere breadth of the wall was no bar to ingress of rodents, but on the contrary furnished increased rat harborage. The very evidence of rat holes seldom seemed to offset the argument that the walls had withstood earthquake shocks and the onslaught of time, and consequently ought to exclude rats. With few exceptions, however, the majority of owners obeyed instructions for rat proofing with alacrity and good will.

Another source of trouble was the Canary Island tiling, which was used almost exclusively as flooring in the San Juan warehouses and large provision stores. These broad flagstones are very brittle and soon become cracked and broken if heavy boxes or barrels are thrown upon them. Especially was it noticed that the corners were most frequently chipped off, permitting the passage of rats, which quickly burrowed and undermined the whole floor space. Unless relaid in cement these tiles were required to be replaced by concrete flooring.

Within the confines of the old city mamposteria structures, such as well-kept dwellings, together with office buildings and retail shops not dedicated to storage or sale of foodstuffs, were exempted, provided there was no evidence of rodent infestation. Those dwellings that corresponded to tenements, with many families herded together, were required to cap the walls and repair the floors. The older part of San Juan contained not a few of these places, generally one family to a room, overcrowded and squalid, with plenty of garbage to attract rats. The patio, or inside court, that obtains in most of the old San Juan buildings, likewise required treatment when connected with a food depot. However rat proof the walls and floor of such a place, the wires and water tubes leading from the roof and the upper story would permit the easy access of rats. The method resorted to in making rat proof these wires and tubes consisted in protecting them by a galvanized-iron collar at the junction of the first and second floors, similar to the rat guards on ship hawsers. Doors and windows were likewise made rat proof where it was possible for a rat to gain entrance to a food depot—the windows being screened with one-half-inch wire mesh. Where doors did not fit snugly, but had a space of an inch or more from the floor, a strip of sheet iron was fastened to the door or the height of the sill raised.

LA MARINA.

This district includes the docks, the large warehouses, and some dwellings. It lies along the water front. The San Juan docks are known as Pier 1, Pier 2, "Old Quartermaster's Dock," and San Antonio Dock.

The two former are constructed as piers. The outer end, where ships lie alongside and discharge cargo, has reenforced concrete floor, protected by galvanized-iron roof and walls. At the end adjoining the shore are located the offices, extending the width of the dock on each side of the entrance. In making these two docks rat proof the doors were so repaired as to fit tightly and were required to be closed at night. The wooden floors of the offices were replaced by concrete, and the double walls were rat proofed by concrete filling at the bottom and heavy timbers at the top. The side of the dock connected with the land was made impervious to the passage of rats by increasing the depth of the walls by a 2-foot concrete foundation. At the juncture of the dock with the land a V-shaped piece of sheet iron extended outward over the water on both sides of the dock, so that a rat could not gain access to the dock by running along the sides. In addition to this the dock space was required to be cleared of all cargo once a week.

The San Antonio Dock presented a different problem. It comprised a very large area of newly made land that, constantly settling, prevented the laying of any concrete floors. It had a galvanized-iron roof and walls, with the bare earth as floor. This place was rat-proofed by a marginal wall of concrete on all sides. On the interior the floor space was divided into some 16 compartments, separated by galvanized-iron partitions sunk 2 feet into the ground and extending upward 4 feet. One compartment is required to be cleared of cargo once in two weeks. At such times the transfer of cargo is effected between sunrise and sunset, so that any rats, if present, penned in by the iron walls can not escape, and are caught and killed. This procedure serves not only to catch any rodents that are present, but is an ever-present indication of the degree of rat population in that place.

The old Quartermaster's Dock has been partly abandoned, being chiefly used in the sugar season when ships come alongside to be loaded with that commodity. Being in disuse in July, the entire plank flooring was removed, leaving the bare ground. Subsequently the railroad company built concrete walls and floor.

All warehouses in the Marina were compelled to put in concrete floor and walls; indeed, on account of the proximity to the docks and the water front, all buildings in this district, whether warehouses and stores, markets or dwellings, were required to have concrete floor and walls.

LA PERLA.

This collection of small hovels was situated below the walls of the old city near the municipal slaughterhouse. Five cases of plague occurred there. With the exception of two or three food depots, rat proofing was accomplished by elevation. The food depots were treated as elsewhere.

La Perla, being situated on a steep inclination, had a number of cellar habitations—one room dug out under a house and boarded up, the floor of the superimposed house comprising the ceiling. These were all ordered destroyed. Prior to the execution of this, however, a case of plague developed in one of these dugouts.

Several small shacks connected with the slaughterhouse were destroyed by the city in preference to rat proofing them. The slaughterhouse itself was made rat proof by placing a wire mesh over the windows, correcting the fit of the doors, and making concrete walls to an annex, the floor of the main building having been constructed of concrete.

TABLE I.—*San Juan (old city), La Perla, and La Marina.*

Food depots.....	203
Piers and wharves.....	4
Dwellings.....	735
Stores and buildings of miscellaneous nature.....	125
Stables.....	8
Total buildings.....	1,075

RAT PROOFED.

Food depots.....	183
Piers and wharves.....	4
Dwellings.....	706
Stores and buildings of miscellaneous nature.....	10
Stables.....	8
In process of compliance.....	33
Noncompliant.....	132

NOTE.—There were 20 food depots listed among the number "Noncompliant" or "In process of compliance"; only 3 were food depots on a large scale. Most of the remaining 17 were either bar, delicatessen or confectionery stores, and the majority of them are of the 33 listed as "In process of compliance."

Of the 132 marked "Noncompliant" the majority belong to the classification "Stores and buildings of a miscellaneous nature," which included shops devoted to dry goods, clothing, shoes, etc., or office buildings. Very few of them harbor rats.

Of the amount spent on rat proofing in the old city, \$100,000 represents reconstructions on a large scale, far exceeding in magnitude the rat proofing repairs ordered, though embracing them.

PUERTA DE TIERRA.

This barrio of the municipality is separated from the old city by a quarter of a mile of unbuilt-upon land except for one or two buildings belonging to the railroad company. For the most part this district is populated by a class of people totally indifferent to every law of hygiene. They live, as a rule, in squalor, and the premises, even at this date, are with difficulty kept free from garbage. Before the epidemic this was not attempted. Frame dwellings prevail in Puerta de Tierra, though there are three or four brick buildings, and since the rat proofing has been in progress several concrete structures have been erected.

This section can be divided for purposes of description into the northern and southern part. The former stretches along the municipal highway known as the Carretera and along San Agustin Street. Practically all cases in Puerta de Tierra were along San Agustin Street. The congestion of houses in Puerta de Tierra is very great and frame tenements abound. Facing San Agustin the majority of buildings are food depots. These were required to have concrete floors and walls. Dwellings of all sizes are crowded into the rear of these premises, and it was in these interior structures that the greater part of the cases of plague occurred. On account of this condition a large majority of the houses were without a number. To obviate the confusion arising therefrom in the first days of the epidemic, at the suggestion of Surg. Grubbs it was planned to give each house a special number. Under the service management this work was completed and each building was designated by a card bearing the district and house number tacked on to the building.

The houses along the Carretera differed from those along San Agustin, chiefly in being for the most part dwellings and having a large number of basement habitations. Any owner whose house had 4 feet of space or more beneath the flooring had constructed dwellings there without proper light, ventilation, or air space. A number of these places were evacuated; some ordered destroyed as being part of the underpinning of the house above and others ordered to be remodeled. The latter procedure embraced the construction of concrete floors and walls and was permitted because of the existing poor housing facilities.

The southern part of Puerta de Tierra is entirely composed of small frame shacks. The population there is chiefly composed of day laborers, and the houses are very close together. Some of the houses at the beginning of the epidemic were close to the ground, but being located, for the most part, at the margin of the bay and on swampy ground that is inundated at high tide, most of the shacks were originally built elevated. It might seem that this shore-line

section would be the first to suffer from the ravages of a plague epidemic. As a matter of fact, the swampy nature of the ground, which prevented rat burrowing, and the elevated construction of the buildings operated for the salvation of these people. Only one case of plague developed in these subbarrios, and that one in August.

On the first appearance of the epidemic, employees of the police and sanitary departments destroyed 50 houses. What made house raising difficult in the early days of the epidemic was the fact that there were practically no jacks in San Juan. In July, the Porto Rico Railway, Light & Power Co. loaned a few jacks to this office, and these were turned over to the poor people in these subbarrios, who raised their own houses. Altogether, there were 441 houses raised in this manner.

Most of the stables were located in Puerta de Tierra. These structures in Porto Rico consist only of the floor and the roof, with supporting timbers, so it was not practicable to make them inaccessible to rodents. They were required, however, to have a concrete floor protected by side walls 2 feet in depth, the crib to stand well removed from all uprights, with a flare from below upward and covered on the outer side by galvanized iron. All grain was required to be kept in rat-proof boxes or houses.

It may be stated that in Porto Rico stables were found not to be the rat harbors they are in the United States, possibly for the reason that grass is chiefly used as feed, with very little grain.

In Puerta de Tierra the worst rat harbors, especially the food depots and many of the dwellings, were completely rat proofed by the latter part of July and early August. This work was practically all finished and Puerta de Tierra rat proof in September, though many small items of the work and repairs were not completed until November.

The insular sanitation service maintained a special force of men in Puerta de Tierra, who kept the streets and premises clean of refuse and garbage, a very great help to the rat-trapping force. In all Puerta de Tierra there were 1,127 buildings; 848 of these were rat proofed, the others not requiring such measures.

Table II gives classification of buildings, with nature and cost of same:

TABLE II.

Food depots.....	69
Dwellings.....	1, 006
Stables.....	44
Miscellaneous buildings.....	8
Total number of buildings in Puerta de Tierra.....	1, 127

RAT PROOFED.

Food depots, concrete floor and walls.....	69
Dwellings:	
By concrete walls.....	170
By elevation.....	507
Stables rat proofed or destroyed by owner.....	44
Miscellaneous.....	8
Shacks destroyed by insular government.....	50
	<hr/>
	848
Dwellings considered rat proof by reason of elevated construction.....	379
	<hr/>
Total (cost \$80,487.27).....	1, 127

SANTURCE.

With the exception of several small subbarrios, Santurce is the better residence part of the city. It contains comparatively few food depots such as groceries, markets, bakeries, etc., and the dwellings are well kept, the householders keeping their premises clean and free from garbage and refuse. Fourteen cases of human plague developed in Santurce, and 12 infected rats were caught. Subbarrios Gandul, Alto del Cabro, Minilla, Melilla, and Campo Alegre contain many small shacks similar to those in south Puerta de Tierra. Fortunately in these places the ground was very marshy or sandy—a light shifting sand that prevents the rodents from burrowing. Both of these factors made for low rat population, with the subsequent facilitation of plague eradication measures.

Table III gives classification of buildings, rat-proofing procedure, and cost. In the outskirts of Santurce were several districts known as Machuchal, Chicharo, and Seboruco. There were a number of shacks in these parts without floors and with thatched roofs. As much for general sanitation as for plague considerations, the owners were required to replace the straw roof by galvanized iron and build an elevated floor. About 100 of these structures were so treated.

TABLE III.

Food depots.....	142
Dwellings.....	2, 961
Stables.....	28
Miscellaneous buildings.....	39
	<hr/>
Total number of buildings in Santurce.....	3, 170

RAT PROOFED.

Food depots, concrete floor and walls.....	142
Dwellings:	
By concrete walls.....	219
By elevation.....	622
Stables rat proofed or destroyed by owner.....	28
Miscellaneous.....	39
Total (cost, \$57,713.57).....	1,050
Dwellings considered rat proof by reason of an elevated construction.....	1,869
Noncompliant (dwellings).....	251
Total.....	3,170

NOTE.—The 251 dwellings listed “noncompliant” were so recorded because they had less elevation than that required by the rat-proofing law. Most of them had some elevation, and very few furnish potential rat harborage.

Rat Proofing Public Buildings.

The rat proofing of public buildings was given the same attention as private property. The interested cooperation of the different Insular and Federal Government officials served to effect the rat proofing of most of the Government constructions where the procedure was needed.

Under the direction of the collector of customs the customs service expended \$3,092.84 in making the San Juan customs warehouses and property rat proof. Authorization was obtained from the Treasury Department for the expenditure of \$10,380.71 in rat proofing property of the customs service in Ponce, Mayaguez, and the other Porto Rican ports.

The War Department authorized rat-proofing work, chiefly in the nature of concrete stables, to the amount of \$5,000 exclusive of the labor involved.

By reason of the active interest of the Governor of Porto Rico, the insular government expended \$7,758.48 on rat-proofing work. The repairs to several Government buildings are still pending because of the expected transfer of authority from the Federal to the Insular Government.

The rat proofing of several parts of the old fortification walls around San Juan has been the cause of more or less correspondence between San Juan and Washington. It is probable that the work will eventually be done.

Legal Procedures.

While the great majority of people complied with the rat-proofing requirements as soon as ordered, it was necessary to refer some cases to court. As usual, these transgressors were chiefly among the landlord class, the ones who could best afford the expenditure.

Some of the defendants were fined, the amounts varying from \$10 to \$100; others discharged by request because of having complied before trial.

The city and district courts of Porto Rico, on account of the vigor with which the judges administered the law, gave very great aid to service operations, and the rat-proofing work was greatly expedited by the efficient and energetic way the cases were prosecuted by the attorney general and his assistants.

In all, 166 cases were referred to court with satisfactory results.

Inspection of Inland-Bound Freight.

Inspectors were stationed at various points in San Juan, so that all merchandise bound for interior points of the island could be inspected and examined or fumigated. These inspection stations were at the railroad freight warehouses, the docks, the ferry station, the express office, and the exit of the highway from San Juan. All articles that could harbor a rat were either unpacked or were subjected to a sulphur fumigation. This last-named procedure was practiced exclusively at the railroad warehouse, where a large sulphur fumigation chamber was built.

All cars leaving San Juan were inspected and required to be rat proof before being used. All dead spaces such as existed between double planking were made tight and inaccessible to rodents. Breaks in car floors or in the side walls were repaired, and windows were made rat proof. All cars when loaded, or if partially loaded and left standing on track over night, were sealed by an inspector. Because of the difficulty in obtaining reliable employees for this inspection work, and the urgency of seeing that different branches of the organization effectively performed their duties, one point at which supervision should have been instituted without loss of time was neglected. The inspector for cars at the San Antonio Dock and surrounding freight yard was not put on duty till July 15. This unfortunate omission may have been responsible for the infection of the Dorado case and the transportation of plague infection to Arecibo. The facts bearing on this possibility will be referred to later on.

This supervision of freight was discontinued December 1. Altogether, 57 rodents were taken from merchandise. Those that were probably killed by fumigation and remained within the packages might have increased the sum total.

To estimate the efficiency of this inspection, the director of sanitation was requested, in October, to make inquiry of the different island health officers as to rodent infestation of freight coming from San Juan. Though several replies stated that rodents had been observed in freight and in cars from San Juan before and during the first days of

the epidemic, none had been seen since initiation of inspection. The notice of rats escaping from cars in the first part of the epidemic was mentioned with some emphasis in the town of Caguas. The total number of pieces of freight inspected up to December 1, was 397,708. This embraced those that were repacked by the inspection force. The number of cars inspected was 2,683; number of pieces of freight fumigated, 15,620.

TABLE IV.

Rodents taken from merchandise	57
Cars inspected.....	2,683
Oxcarts carrying inland-bound freight inspected.....	6,075
Pieces of freight fumigated.....	15,620
Pieces of freight inspected (including those repacked).....	397,708

Trapping and poisoning of rodents.

As soon as the service plan of organization was decided upon, it was ascertained that the local market at most could supply but slightly over 100 traps. A cable order was sent to the States for 1,500 snap traps and 1,500 cage traps of a selected pattern. In the meantime the entire local supply was purchased. In all, about 2,500 traps were assigned to San Juan, it being considered that each trapper could attend to 60 traps. Later on this number was increased to 9,000 traps. Four or five thousand were sent to different points outside of San Juan.

The method of trapping did not differ from service methods used in San Francisco. For this part of eradication work the municipality was divided into 10 districts, one foreman and four men being assigned to each. Later on, as rats became scarce, additional foremen were employed, one foreman to two trappers. Each trapper was paid a bounty for each rat caught in addition to his salary. In certain parts of the estuaries bordering on Puerta de Tierra and Santurce rats make nests, live and breed, in the swamp shrubbery known as the "mangle." When the tide recedes the rats make widespread excursions in search of food, returning to their nests, or the branches of the shrubbery, when the tide is flooding. To destroy these rats, not only were traps and poison used, but some of the employees also used rifles, going out in boats at high tide. Where possible the shrubbery was cut down.

In the first week of July in the entire city 72 rats were captured, a daily catch of about 10; in the second week, 294, a daily average of 42. The number increased daily up to the latter part of July, when on July 28 the maximum catch was attained—178 rodents. A diminution in the rat catch commenced the first week in August and continued steadily, so that in September it had dropped to about half; in October and November it had fallen to one-fifth, the daily average

for the week November 1 to 7 being 28. The lowering of the rat population was effected by the combined rat catching and poisoning, the success of which was due to rat proofing. The steady decrease in captured rodents was most marked in Puerta de Tierra where earliest and most careful attention was given to rat proofing. A separate record for each district was not commenced until July 10. In the week, July 10 to 16, 95 rats were trapped in Puerta de Tierra. During the last week in July the catch for this district was 205.

On September 11, when the rat catch in Puerta de Tierra had fallen to 22 per cent of the July maximum, the last two infected rodents were trapped in that barrio. This decrease is all the more accentuated by the fact that the trappers were week by week becoming more experienced, the number of foremen in September being doubled so that the supervision was more strict, and the rat bounty was increased from 5 to 10 cents with an offer of \$1 for any infected rat taken. All these factors would naturally operate to cause an increase in the number of rats trapped, so that from a comparative estimate it would seem that the percentage of reduction was really greater than is indicated by the actual number of rodents caught.

The last case of plague in the municipality occurred on September 13, when the daily rat catch in the entire city had fallen to 50 per cent of the earlier maximum catch. Between the early morning hours, when the trappers turned in their catch, and the afternoon hours, when traps were baited, the men distributed poison. Arsenic and phosphorus poisons made in the insular chemical laboratory were used. Six hundred pounds of poison were thus distributed between July 1 and January 1.

As to the details of trapping: Each foreman was assigned a fixed district. In turn he would so place his trappers that there was no duplication of labor or trapping in the same territory. Each foreman was personally held responsible for the traps, and he made his trappers responsible to him for the property intrusted to them. The foreman kept a list of the location of every trap in his district, and by daily rounds with the trappers verified the location and saw that the trapper was promptly attending to his duties. A supervising inspector had charge of the foremen and made rounds of inspection. Despite these precautions, however, it can not be said that the work of the trappers has been satisfactory owing to the difficulty of getting competent men to do the work. There were a few exceptions. Altogether there were 269 rat trappers employed in San Juan from the beginning of the work up to February 15, though this force did not exceed at any one time 40 men for the city.

Under the subheading of "Extension of eradivative and preventive measures to points outside of San Juan" mention will be made of trapping and poisoning in other island towns.

TABLE V.—*Classification of all rodents examined in Porto Rico from June 23, 1912, to Feb. 15, 1913.*

<i>Mus norvegicus</i>	26,532
<i>Mus rattus</i>	4,514
<i>Mus alexandrinus</i>	7,933
<i>Mus musculus</i>	6,533
Mongoose.....	258
Unclassified.....	309
Total.....	46,079

NOTE.—The unclassified were those examined during the first week of laboratory examination.

TABLE VI.—*Weekly rat catch in Puerta de Tierra.*

[All dates inclusive.]

	Rats.	Mice.		Rats.	Mice.
July 10 to 13.....	15	.....	Nov. 3 to 9.....	30	47
July 14 to 20.....	193	5	Nov. 10 to 16.....	21	35
July 21 to 27.....	176	.....	Nov. 17 to 23.....	29	60
July 28 to Aug. 3.....	174	.....	Nov. 24 to 30.....	31	47
Aug. 4 to 10.....	154	.....	Dec. 1 to 7.....	20	57
Aug. 11 to 17.....	136	.....	Dec. 8 to 14.....	45	64
Aug. 18 to 24.....	102	.....	Dec. 15 to 21.....	20	68
Aug. 25 to 31.....	98	7	Dec. 22 to 28.....	10	98
Sept. 1 to 7.....	41	7	Dec. 29 to Jan. 4.....	20	70
Sept. 8 to 14.....	58	13	Jan. 5 to 11.....	14	126
Sept. 15 to 21.....	49	34	Jan. 12 to 18.....	34	99
Sept. 22 to 28.....	51	21	Jan. 19 to 25.....	28	98
Sept. 29 to Oct. 5.....	39	27	Jan. 26 to Feb. 1.....	14	76
Oct. 6 to 12.....	48	43	Feb. 2 to 8.....	28	57
Oct. 13 to 19.....	33	92	Feb. 9 to 15.....	18	80
Oct. 20 to 26.....	26	78			
Oct. 27 to Nov. 2.....	38	7	Total.....	1,793	1,416

TABLE VII.—*Weekly rat catch in Santurce.*

	Rats.	Mice.		Rats.	Mice.
July 10 to 13.....	94	41	Nov. 3 to 9.....	154	9
July 14 to 20.....	160	6	Nov. 10 to 16.....	142	16
July 21 to 27.....	178	.....	Nov. 17 to 23.....	92	29
July 28 to Aug. 3.....	297	.....	Nov. 24 to 30.....	87	25
Aug. 4 to 10.....	276	.....	Dec. 1 to 7.....	108	31
Aug. 11 to 17.....	240	.....	Dec. 8 to 14.....	110	40
Aug. 18 to 24.....	255	.....	Dec. 15 to 21.....	124	64
Aug. 25 to 31.....	299	8	Dec. 22 to 28.....	74	76
Sept. 1 to 7.....	319	14	Dec. 29 to Jan. 4.....	107	84
Sept. 8 to 14.....	336	9	Jan. 5 to 11.....	94	68
Sept. 15 to 21.....	342	8	Jan. 12 to 18.....	144	74
Sept. 22 to 28.....	341	13	Jan. 19 to 25.....	118	92
Sept. 29 to Oct. 5.....	308	12	Jan. 26 to Feb. 1.....	185	72
Oct. 6 to 12.....	254	3	Feb. 2 to 8.....	168	75
Oct. 13 to 19.....	281	20	Feb. 9 to 15.....	206	67
Oct. 20 to 26.....	208	14			
Oct. 27 to Nov. 2.....	222	10	Total.....	6,323	990

TABLE VIII.—*Weekly rat catch in San Juan (the old city, Marina, and La Perla).*

	Rats.	Mice.		Rats.	Mice.
July 10 to 13.....	15	8	Sept. 15 to 21.....	179	7
July 14 to 20.....	121	6	Sept. 22 to 28.....	184	23
July 21 to 27.....	322	.....	Sept. 29 to Oct. 5.....	102	33
July 28 to Aug. 3.....	357	.....	Oct. 6 to 12.....	145	38
Aug. 4 to 10.....	363	.....	Oct. 13 to 19.....	143	59
Aug. 11 to 17.....	257	.....	Oct. 20 to 26.....	82	19
Aug. 18 to 24.....	233	.....	Oct. 27 to Nov. 2.....	77	48
Aug. 25 to 31.....	198	15	Nov. 3 to 9.....	59	6
Sept. 1 to 7.....	166	20	Nov. 10 to 16.....	57	56
Sept. 8 to 14.....	131	30	Nov. 17 to 23.....	85	57

TABLE VIII.—Weekly rat catch in San Juan (the old city, Marina, and La Perla)—Con.

	Rats.	Mice.		Rats.	Mice.
Nov. 24 to 30.....	81	44	Jan. 12 to 18.....	100	70
Dec. 1 to 7.....	122	36	Jan. 19 to 25.....	134	83
Dec. 8 to 14.....	73	55	Jan. 26 to Feb. 1.....	93	98
Dec. 15 to 21.....	152	92	Feb. 2 to 8.....	93	72
Dec. 22 to 28.....	97	96	Feb. 9 to 15.....	119	66
Dec. 29 to Jan. 4.....	68	70			
Jan. 5 to 11.....	82	55	Total.....	4,490	1,262

NOTE.—The record for the weekly rat catch by districts in the municipality was not started until July 10.

TABLE IX.—Weekly rat catch in San Juan, Santurce, and Puerta de Tierra.

	Rats.	Mice.		Rats.	Mice.
July 2 to 6.....	56		Nov. 3 to 9.....	243	62
July 7 to 13.....	160	49	Nov. 10 to 16.....	220	107
July 14 to 20.....	488	12	Nov. 17 to 23.....	206	146
July 21 to 27.....	695		Nov. 24 to 30.....	199	116
July 28 to Aug. 3.....	828		Dec. 1 to 7.....	250	124
Aug. 4 to 10.....	793		Dec. 8 to 14.....	229	159
Aug. 11 to 17.....	633		Dec. 15 to 21.....	296	224
Aug. 18 to 24.....	590		Dec. 22 to 28.....	180	270
Aug. 25 to 31.....	595	30	Dec. 29 to Jan. 4.....	195	224
Sept. 1 to 7.....	526	41	Jan. 5 to 11.....	190	249
Sept. 8 to 14.....	525	52	Jan. 12 to 18.....	278	245
Sept. 15 to 21.....	570	49	Jan. 19 to 25.....	280	273
Sept. 22 to 28.....	576	57	Jan. 26 to Feb. 1.....	292	246
Sept. 29 to Oct. 5.....	449	72	Feb. 2 to 8.....	289	204
Oct. 6 to 12.....	447	84	Feb. 9 to 15.....	344	213
Oct. 13 to 19.....	465	171			
Oct. 20 to 26.....	316	101	Total.....	12,947	3,665
Oct. 27 to Nov. 2.....	334	65			

NOTE.—Figures for latter part of June and early July do not indicate total number of rodents destroyed or examined, as many rodents were killed by citizens, some being sent to the laboratory.

Source of all rodents examined in the laboratory from June 23, 1912, to Feb. 15, 1913.

Towns.	Rats and mice.	Mon-goose.	Towns.	Rats and mice.	Mon-goose.
Aibonito.....	12		Naguabo.....	21	
Adjuntas.....	6		Penuelas.....	5	
Aguada.....	4		Ponce.....	3,304	4
Agua Buenas.....	5		Rio Piedras.....	1,895	26
Arroyo.....	3		Rincon.....	3	
Anasco.....	13		San Juan.....		
Aguadilla.....	507		Puerta de Tierra... 5,176		
Arecibo.....	3,157	2	Santurce..... 8,918		
Barceloneta.....	15		San Juan..... 5,707		
Bayamon.....	1,883	4		19,801	180
Catano.....	44		Rio Grande.....	43	
Camuy.....	4		Steamship Brazos.....	119	
Comerio.....	21		Steamship Carolina.....	26	
Cabo Rojo.....	2		Steamship Ponce.....	19	
Carolina.....	2,000	1	Steamship Hostilius.....	1	
Caguas.....	2,445	25	Steamship Luckenbach.....	1	
Coamo.....	9		Schooner Henry Kregse.....	14	
Cayey.....	15		Schooner Sylvia Hall.....	11	
Dorado.....	49		San German.....	36	
Fajardo.....	12		San Sebastian.....	29	
Guaynabo.....	6		Salinas.....	9	
Guayanilla.....	1		Santa Isabel.....	4	
Gurabo.....	19		Sabana Grande.....	18	
Guayama.....	5		San Lorenzo.....	5	
Humacao.....	17		Toa Baja.....	6	
Juncos.....	11		Toa Alta.....	5	
Loiza.....	32		Yauco.....	535	
Lares.....	30		Yabucoa.....	10	
Las Marias.....	6		Vega Alta.....	6	
Lajas.....	21		Vega Baja.....	16	
Moca.....	168				
Manati.....	600		Total.....	45,821	258
Mayaguez.....	8,798	16			

[NOTE.—To be continued in next issue.]

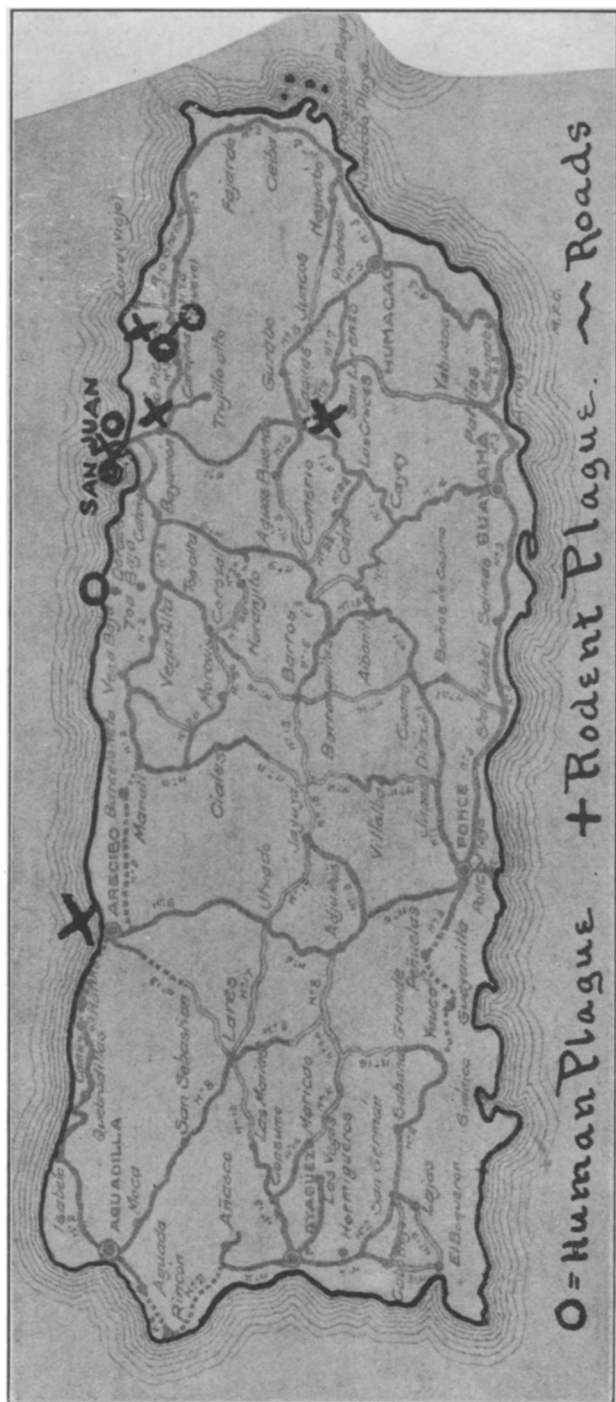


Fig. 1.—MAP OF PORTO RICO, SHOWING LOCALITIES IN WHICH PLAGUE INFECTION OCCURRED.



Fig. 2.—AN EXAMPLE OF THE "MAMPOSTERIA" (BRICK AND MUD MASONRY) WALLS OF THE "OLD CITY" IN SAN JUAN RIDDLED WITH RAT HOLES.



Fig. 3.—FRAME WAREHOUSE ON WATER FRONT, SAN JUAN, SUBSEQUENTLY TORN DOWN AND REPLACED BY REINFORCED CONCRETE BUILDING.



Fig. 4.—INTERIOR VIEW OF SAN ANTONIO DOCK, SHOWING APARTMENTS PARTITIONED OFF BY GALVANIZED IRON.

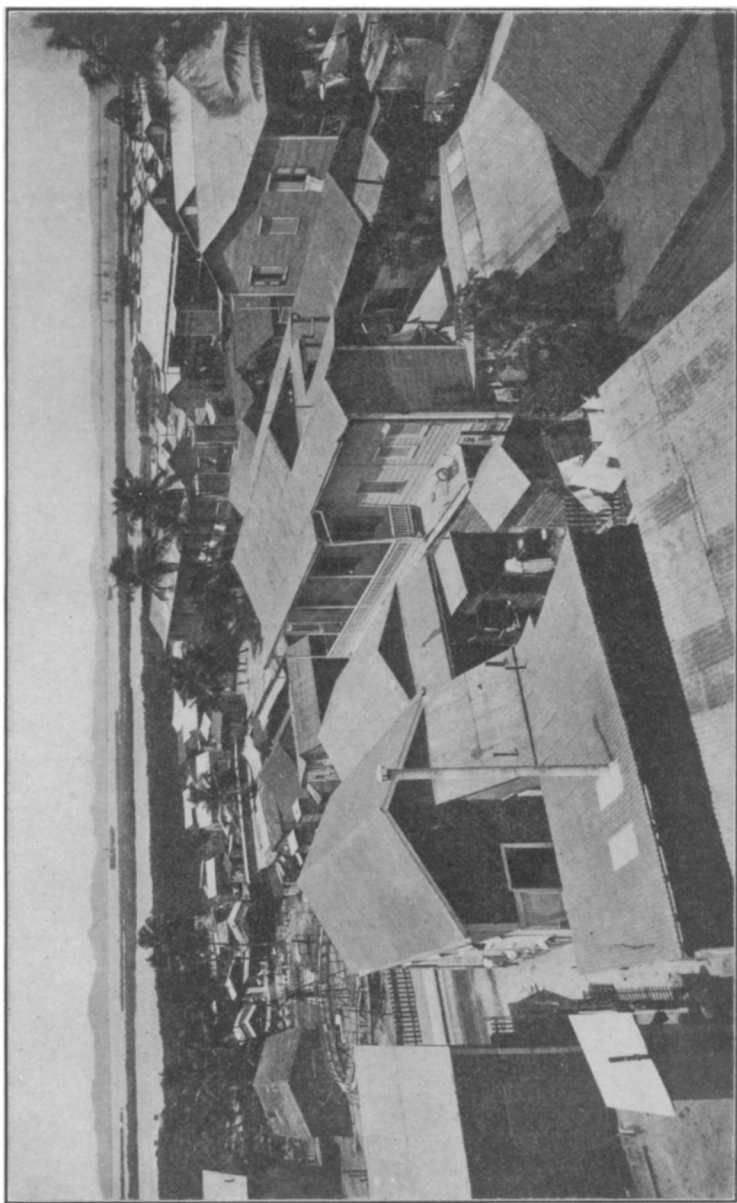


Fig. 5.—SECTION OF PUERTA DE TIERRA, SHOWING CONGESTION OF BUILDINGS.